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Indian Standard

SPECIFICATION FOR PREPREG FOR USE IN MULTILAYER PRINTED BOARDS

UDC 621·315·619 : 621·3·049·75

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3

February 1989

Indian Standard

SPECIFICATION FOR PREPREG FOR USE IN MULTILAYER PRINTED BOARDS

0. FOREWORD

0.1 This Indian Standard was adopted by the Bureau of Indian Standards on 27th January 1988, after the draft finalized by the Printed Circuits Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 Assistance has been drawn in the formulation of this standard from IEC Pub 249-3-1 (Second edition) (1981) 'Base material for printed circuits Part 3 : Special materials used in connection with printed circuits, Specification No. 1 : Prepreg for use as bonding sheet material in the fabrication of multilayer printed boards', issued by the International Electrotechnical Commission (IEC).

1. SCOPE

1.1 This standard specifies the requirements for two types of epoxide resin impregnated woven glass fabric with the resin cured to a B-stage. They are used for bonding together printed circuits formed from metal-clad epoxide glass laminates to produce multilayer printed boards.

2. TERMINOLOGY

2.0 The terms and definitions as given in IS : 1885 (Part 6)-1978* shall apply for the purpose of this standard.

3. DESIGNATIONS

3.1 The two types of prepregs specified in this standard shall be designated as follows :

a) *Type* G — General purpose epoxide resin impregnated glass fabric, and

b) *Type* GF — Epoxide resin impregnated glass fabric of defined flammability.

4. MATERIALS AND CONSTRUCTION

4.0 General — The bonding sheet shall consist of woven glass fabric impregnated with epoxide resin cured to a B-stage. The flammability of Type GF material shall be defined in terms of the requirements of **5.3.2**.

4.1 Woven Glass Fabric

4.1.0 *General* — The glass fabric shall be plain weave glass cloth, woven from continuous filament yarns made from electrical grade glass containing not more than 1 percent alkali metal oxide expressed as (Na_2O). The fabric shall be finished with a finishing material compatible with epoxide resins.

4.1.1 *Properties* — The following properties of the glass fabric before impregnation shall be stated by the manufacturer of the bonding sheet material :

a) Nominal thickness,

b) Nominal mass per unit area, and

c) Nominal thread count (giving the warp count as the first number and the fill or weft count as the second number).

The properties of some of the most widely used glass fabrics before impregnation are listed below:

Nominal Thickness µm	*Nominal Mass per Unit Area* g/m²	*Nominal Thread Count (Warp Ends and Weft Picks) Threads* per cm
25	20	24 × 20
50	47	24 × 19
75	71	16 × 15
75	84	24 × 25
100	109	24 × 23

5. BONDING SHEET MATERIAL

5.1 Thickness (after Laminating) — The manufacturer of the bonding sheet material shall state the average thickness per layer of the impregnated fabric after laminating and curing in accordance with his recommendations. A standard procedure for determining the average thickness is given in **6.5**.

Permitted variations in thickness of laminated and cured material shall be subject to agreement between the purchaser and the supplier.

NOTE — This thickness is influenced by laminating conditions and should not be assumed valid for conditions other than those recommended.

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*Electrotechnical vocabulary: Part 6 Printed circuits (*first revision*).

5.2 Appearance — There shall be no breaks in the glass fabric, foreign matter or other imperfections present which will be detrimental to the intended use of the bonding sheet material.

Cracks in the resin surface shall not be a cause for rejection provided there is no evidence of excessive powdering.

5.3 Properties of Bonding Sheet Material — The bonding sheet material shall meet the following requirements:

5.3.1 *Properties in B-Stage (Prior to Laminating)* — These shall be in accordance with the requirements given below:

Property	*Test Method (Clause Ref)*	*Requirements*
Volatiles content, percent	6.3	Not greater than 0·75%
Resin content, percent	6.1	$X^* \pm 5$ for any specimen
Resin flow, percent	6.2	$X^* \pm 3$ for nominal values $X \leqslant 20\%$ $X^* \pm 5$ for nominal values $X > 20\%$
Gel time, seconds	6.4	$X^* \pm 15\%$ of the specified nominal value X

5.3.2 *Properties of Bonding Sheet Material when Laminated* — Properties of a laminate of 0·8 mm nominal thickness when made in accordance with the supplier's recommended procedure shall be as specified in Table 1. If very thin material of high resin content and flow cannot reliably be pressed as a laminate as thick as 0·8 mm, the thickness of the laminate and the requirements shall be agreed upon between the purchaser and the supplier.

5.3.2.1 The test methods referred to in **5.3.2** include the preparation of test specimens by removing foil from samples of metal-clad laminate. This stage shall be omitted for the testing of bonding sheet material when laminated.

5.3.3 *Permanence of Properties* — The values for volatile content, resin flow and gel time agreed between the purchaser and the supplier shall remain within the limits specified in this standard for a minimum of 90 days from the date of despatch when the material is kept under the manufacturer's recommended storage conditions of temperature and relative humidity, in the absence of light or other catalytic influence.

5.4 Packaging and Marking

5.4.1 All the sheets of bonding sheet material in a package shall be laid in the same direction with respect to the warp of the glass fabric, and that direction shall be suitably indicated.

5.4.2 If supplied in rolls, the ends of the rolls shall be suitably protected.

5.4.3 Each package of bonding sheet material shall be suitably marked with the manufacturer's name, number of this specification, type designation, lot number, date of despatch, nominal resin content, nominal resin flow, nominal gel time and the recommended storage conditions.

5.5 Additional Requirements, for Bonding Sheet Material when Supplied in Rolls

5.5.1 The deviation from the nominal width of rolls more than 800 mm wide shall not exceed ± 25 mm.

5.5.2 The deviation from the nominal width of rolls slit to a specified width shall not exceed ± 3 mm.

5.5.3 The deviation in length of rolls shall be less than 1 m.

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*X = respective nominal values to be agreed between the purchaser and the supplier.

TABLE 1 PROPERTIES OF BONDING SHEET MATERIAL WHEN LAMINATED

(*Clause* 5.3.2)

Sl No.	Property	Test Method Clause Ref of IS : 5921 (Part 1)-1983*	Requirements	
(1)	(2)	(3)	(4)	
1.	Flammability	7.2	Flaming combustion time after each application of the test flame for each test specimen	$\leqslant$ 30 s
			Total flaming combustion time for the ten flame applications for each set of five specimens :	$\leqslant$ 250 s
			Glowing combustion time after the second removal of the test flame :	$\leqslant$ 60 s
			Flaming or glowing combustion up to the holding clamp :	None
			Dripping flaming particles that ignite the tissue paper :	None
2.	Heat shock	6.9	No blistering or delamination after 20 s	
3.	Permittivity after damp heat steady state	5.4	5·5, *Max*	
4.	Dissipation factor after damp heat steady state	5.4	0·035, *Max*	
5.	Electrical strengh normal to plane of sheet (optional)	—	10 kv/mm, *Min*	

*Specification for metal-clad base material for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests (*first revision*).

5.5.4 There shall be no more than two splices in any 100 m of material supplied in full width or five in any 100 m of material slit to specified width.

5.5.5 For the supplier's quality control, areas may have been removed over the entire width from the material supplied but the total area removed shall not exceed 2 percent of the total area in the roll.

NOTE — An explanation may be required for **5.5.4** and **5.5.5**. In order for the supplier to control the quality of bonding sheet material which is produced in a continuous process, he should periodically cut from the material, samples to test specimens for resin content, volatile content gel time and flow.

If the material is to be supplied in rolls, some of the areas from which test samples have been removed may be completely cut out, and the resulting lengths may then be spliced into a roll, subject to the requirements of **5.5.4**. This procedure will permit tests at intervals of 50 m.

In some instances, this frequency of testing is not sufficient, so **5.5.5** permits removal of additional test samples without creating splices. When the material is to be supplied as slit widths in rolls, the width may be less than the area required for test samples. Consequently, removal of areas for test samples will usually require that the areas for test samples be cut out before slitting and the remaining lengths then spliced into a roll, subject to the requirements of **5.5.4**.

6. METHODS OF TEST FOR BONDING SHEET MATERIAL

6.1 Resin Content

6.1.1 *Test Specimens* — Three specimens, 100 ± 10 mm square, shall be taken from positions along a line normal to the warp of the fabric, with the diagonals of the specimens parallel to the warp and weft threads. One shall be taken from a position equidistant from the edges, and the other two from positions on opposite sides of the first with their outer extremities 50 ± 25 mm from each edge or selvedge (*see* Fig. 1).

All loose particles and projecting fibres shall be removed from the specimens.

Additional specimens may be taken from any position across the width of the fabric provided that no part of the specimens shall be less than 25 mm from an edge or selvedge.

6.1.2 *Procedure*

6.1.2.1 *Determination of resin content of one specimen* — A crucible of suitable size shall be heated in a muffle furnace at 550 ± 20°C for 15 min, allowed to cool to room temperature in a desiccator and weighed to the nearest 1 mg (M_1).

The test specimen, cut to convenient size, shall be weighed in the crucible (M_2), heated in a muffle furnace at 550°C for 1h, allowed to cool to room temperature in a desiccator and weighed again to the nearest 1 mg. The heating, cooling and weighing shall be repeated until two consecutive weighings (M_3) agree within 2 mg.

The resin content shall be calculated as follows:

$$\text{Resin content (percent)} = \frac{100\,(M_2 - M_3)}{M_2 - M_1} - \text{Volatiles content (percent)}$$

6.1.2.2 The resin content of the remaining specimens shall be determined in the same manner.

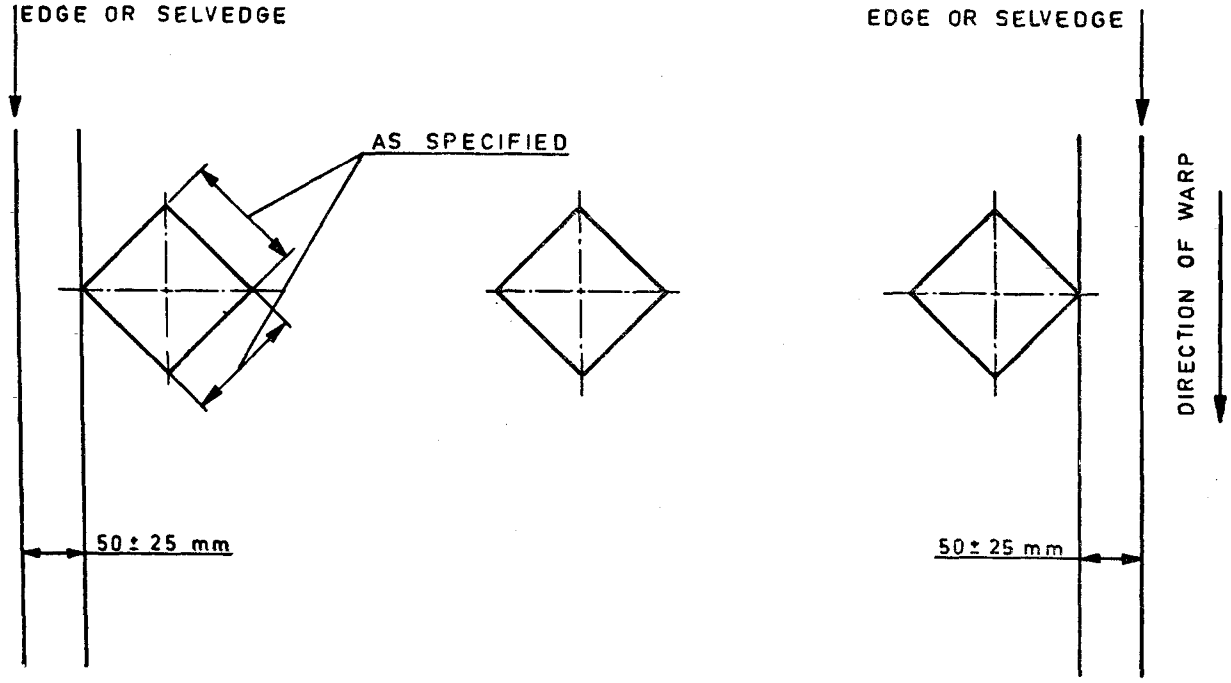

FIG. 1 POSITION OF SPECIMENS FOR RESIN CONTENT, RESIN FLOW, VOLATILES, CONTENT AND THICKNESS

6.1.2.3 The volatile content used in these calculations shall be determined on the same batch of material by the method of **6.3**.

NOTE — For purposes of routine quality control during manufacture, it is usual to compare the mass of impregnated specimens with that of the specimens of same size taken from corresponding positions across an unimpregnated sample of the same roll of glass fabric. The calculation of resin content is still made as in **6.1.2.1** above, except that no weighings with a crucible are involved and that the amount of finish has to be subtracted too. This amount shall be determined on the unimpregnated material by the procedure given in **6.1.2.1**.

6.2 Resin Flow

6.2.1 *Test Specimens* — Between eight and 20 specimens, each, 100 ± 1 mm square, shall be taken to aggregate a mass of 10 to 30 g. The specimens shall be cut from positions along a line normal to the warp of the fabric with the diagonals of the specimens parallel to the warp and weft threads.

No specimens shall be cut from a position within 25 mm of an edge or selvedge and the required number of specimens shall be taken from positions distributed uniformly across the width of the sheet or roll of material (*see* Fig. 1). All loose particles and projecting fibres shall be removed from the material.

NOTE — The stack of specimens is defined in terms of both number and aggregate mass in order to accommodate the wide range of possible materials. It is advisable to use at least eight specimens in order to get a satisfactory result and it is inadvisable to use more than 20 specimens of material having very high resin content and flow because of difficulties in carrying out the test. These restrictions combined with those for aggregate mass define a satisfactory stack for most materials.

6.2.2 *Procedure* — The specimens shall be staked together with their edges in careful alignment. They may be fastened together with a staple or by other suitable means. The stack of specimens shall then be weighed to the nearest 0·01 g (M_1).

Place the stack of specimens centrally between plates of stainless steel or other suitable metal 1·6 ± 0·8 mm thick and not less than 125 mm square, prepared with a suitable release agent. Insert the assembly of plates and test specimens in a press. The heating plates of the press shall have been preheated to a temperature of 170 ± 3°C.

The press shall be closed on the specimen stack and a pressure of 1·50 ± 0·15 MPa shall be applied within a maximum of 5 s elapsed time. Within 3 min of the closure of the press, the temperature at the interface between the stack and the metal plates shall be not less than 165°C. The pressure shall be held until there is no further flow of resin, or for 10 min, whichever is longer. When the laminate is cured, the press shall be opened and the specimen removed and allowed to cool to room temperature. A piece having an area of 5 000 mm² shall be removed from the central area of the laminate in the form of a square whose sides are 70·7 ± 0·4 mm or a circular disc 79·8 ± 0·4 mm in diameter, and weighed to the nearest 0·01 g (M_2).

The resin flow shall be calculated and reported as follows to the nearest 1 percent.

$$\text{Resin flow (percent)} = \frac{100\,(M_1 - 2M_2)}{M_1}$$

NOTE — If other specimen sizes are used for information, they will not give the same numerical results and may not be used to determine compliance with specification.

6.3 Volatiles Content

6.3.1 *Test Specimens* — Three specimens 100 ± 10 mm square shall be cut from the material with the diagonals of the square parallel and normal to the warp threads. The specimens shall be cut from positions along a line normal to the warp of the fabric, one from a position equidistant from the edges, and the other two from positions on opposite sides of the first but not within 25 mm of an edge or selvedge (*see* Fig. 1).

All loose particles and projecting fibres shall be removed from the specimens. A small hole may be punched near one corner of each specimen through which it may be suspended on a hook in an over for the test.

6.3.2 *Procedure* — The three specimens shall be weighed together to the nearest 1 mg (M_1), heated in a circulating-air oven at 163 ± 3°C for 15 min ± 15 s cooled to room temperature in a desiccator and re-weighed together to the nearest 1 mg (M_2). To minimize regain of moisture from the atmosphere, the second weighing shall be made as soon as possible following removal from the desiccator.

The volatiles content shall be calculated and reported as follows :

$$\text{Volatiles content (percent)} = \frac{100\,(M_1 - M_2)}{M_1}$$

6.4 Gel Time

6.4.1 *Test Specimen* — A number of pieces approximately 100 mm square or of another convenient size shall be cut from areas uniformly distributed across the width of the sheet or web but excluding the area within 25 mm of each edge or selvedge.

6.4.2 *Procedure* — By folding or crushing these pieces, dry resin shall be detached from the material if possible and collected on a smooth clean surface. Any glass fibre present shall be removed by sieving. From this resin, between 200 and 300 mg shall be taken with a measuring spoon to form the test specimen and poured in the form of a small cone on to one spot of a hot plate maintained at a surface temperature of 170 ± 2°C. A suitable method of temperature measurement is the observation on the surface of a series of crystals with melting points in the range of 168 to 172°C.

Alternatively, in the case of materials too soft to detach dry resin by crushing, the resin required may be obtained by pressing the folded stack of material in contact with the hot plate and squeezing out the melted resin.

A timer shall be started at the moment the resin comes into contact with the hot plate, whichever method is used.

After the resin has melted and when 75 percent of the specified gel time has elapsed, the resin shall be stirred using a wooden stick approximately 3 mm in diameter, holding the stick as nearly vertical as possible and mixing the centre as well as the edges of the melted resin. While stirring, the diameter of the pool of melted resin shall not exceed 25 mm. Approaching the gel point, the resin becomes tacky and forms strings : the gel point is reached when it no longer forms strings and is no longer tacky but is still elastic. At this point, the timer is stopped and the elapsed time measured in seconds is taken as the gel time.

NOTE — The determination of gel time may also be carried out using a sample of the resin contained in a rotational viscometer, in which case more information about the flow characteristics of the resin may be obtained. If this method is used, the viscosity value corresponding to the gel point shall be defined by correlation with the test described above.

6.5 Thickness

6.5.1 *Test Specimens* — Two specimens at least 100 mm square, shall be taken from positions along a line normal to the warp of the fabric with the diagonals of the specimens parallel to the warp and weft threads. One specimen shall be taken from a position equidistant from the edges and the other with its outer extremity 50 ± 25 mm from an edge or selvedge (*see* Fig. 1). All loose particles and projecting fibres shall be removed from the specimens.

6.5.2 *Lamination* — The specimens shall be stacked together with their edges in careful alignment. The stack of the two specimens shall be made into a laminate by pressing between plates of stainless steel or other suitable metal with uniform thickness in the range of 0·8 to 2·4 mm, using a release agent suitable for the resin type. The laminating and curing shall be carried out in accordance with the recommendations of the manufacturer of the bonding sheet material.

After lamination, the press shall be opened and the specimen removed and allowed to cool to room temperature. A strip 25 mm wide shall be cut from each edge of the laminate.

6.5.3 *Procedure* — The thickness of the cured laminate is calculated from four individual measurements with a micrometer. The measurements shall be carried out in the middle of each side at a distance of 5 to 10 mm from the edge.

6.5.4 *Report* — One half of the calculated average is to be reported as the thickness of the bonding sheet material.

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